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Generator in conjunction with an externally cooled rectifier

The invention relates to an internal combustion engine, which has an electrical generator for a DC voltage network and an alternating current machine, which is arranged externally on the internal combustion engine, as well as a rectifier which electrically connects the DC voltage network and the alternating current machine, with the rectifier having at least two heat sinks, which each have at least one associated diode and are in the form of a negative pole or positive pole.

An electrical machine or a three-phase generator with a rectifier unit is already known from DE 197 05 228 A1. In this case, the rectifier unit is provided on the rear end face of the end frame, with the positive or negative heat sink together with the positive and negative diodes, respectively, being connected to a circuit board with the interposition of an insulating panel, like a sandwich. The heat sink has two or more cooling openings for a cooling flow which is produced by the fan of the machine, and at least some of the cooling openings are provided with cooling ribs.

The invention is based on the object of designing and arranging a three-phase machine for an internal combustion engine in such a way as to ensure optimum cooling of the rectifier.

According to the invention, the object is achieved in that at least the heat sink of the rectifier is arranged physically separately from the alternating current machine, with the heat sink being provided in the area of a fan, and the heat sink having an

associated fan. This means that the rectifier can be optimally cooled independently of the particular power class. The physical space which is available on the internal combustion engine can be optimally utilized for the alternating current machine. Furthermore, the cooling power which is provided on the alternating current machine is available for the alternating current machine. The fan may in this case be an existing cooler fan, or an additional, external fan.

For this purpose, it is advantageous for the rectifier to have an associated regulator, with the regulator being arranged between the heat sink and the alternating current machine, on a frame part or frame longitudinal support of the internal combustion engine. The regulator is provided with a separate electrical coupling, so that it need not be arranged immediately adjacent to the rectifier or to the alternating current machine.

An additional option, according to one development, is for the fan, which is in the form of a cooler fan, to have a rotation speed which is dependent on the DC voltage network voltage, with the cooler fan generating an increase in rotation speed if the DC voltage network voltage drops below a critical value, U_{min}. Adequate cooling power for the cooler fan for the rectifier is thus ensured in the event of electrical overloading of the alternating current machine and in the event of the voltage drop resulting from this. The hydrostatic cooler fan is in this case driven via a bypass proportional valve. The other control parameters are the boost air temperature and coolant temperature of the internal combustion engine. The parameters are output by engine regulation as a partial voltage value of the on-board network voltage. The on-board network voltage thus represents an indirect control parameter for fan control.

It is also advantageous for the heat sink to be arranged via at least one spacing sleeve on the rectifier housing, which is formed from plastic, with the spacing sleeve being in the form of a voltage tap for the DC voltage network. The heat sink is connected to the rectifier housing by means of plastic screws. The mechanical attachment of the heat sinks is thus optimally coupled to the electrical insulation, since the diodes are mechanically and electrically coupled to the respective heat sink.

For this purpose, it is also advantageous for the rectifier housing to be arranged in or with respect to the flow direction of the cooling air in the area of a cooler fan, with the first face, which is associated with the fan housing or the cooler fan, being open, and the second, opposite face having two or more ventilation openings for cooling air. The open first face is protected against access or damage by the cooler fan. The second face as well as the edge area of the rectifier housing are freely accessible and are provided with ventilation openings or ventilation slots in order to ensure convection. The ventilation slots are in this case aligned such that they correspond to the cooling ribs, and have a similar projection area with respect to the flow direction of the cooling air thus ensuring optimum convection and flow of the cooling air between the cooling ribs and out of the rectifier housing.

According to one preferred embodiment of the solution according to the invention, provision is finally made for a cable duct to be provided between the rectifier, the regulator and/or the alternating current machine, with the cable duct being at least partially in the form of an electromagnetic screen. The relatively large alternating current in the electrical connecting line

between the rectifier and the alternating current machine generates an AC voltage field, which is not uncritical and leads to radiated emission of an electromagnetic field. There is thus no need for additional screening.

It is of particular importance for the present invention for the heat sink to have two or more cooling ribs which are connected to one another and/or are attached to a rectifier housing on at least one side, and are open downwards in the direction of the vertical. The open configuration can prevent the continuous accumulation of dirt, since it falls downwards. The joint connection on the upper face is used firstly for joint cooling and secondly for joint potential formation, as a positive or negative pole.

In conjunction with the configuration and arrangement according to the invention, it is advantageous for the rectifier to have a power of between 2.5 kW and 3.6 kW and to be formed from at least 12 diodes, with at least two diodes in each case being connected in parallel.

It is also advantageous for the alternating current machine to be attached to the internal combustion engine together with a further unit, and to have a common drive with this further unit. This means that there is no need to redevelop the internal combustion engine or its crankcase.

It is also advantageous for the heat sink, which holds the diodes, of the rectifier to be arranged physically separately from the alternating current machine in the flow direction of the cooling air of a fan which is in the form of a cooler fan, and in its immediate vicinity, with the rectifier housing which holds the heat sink having two or more ventilation openings, and the regulator for the rectifier being arranged

physically separately between the rectifier housing and the alternating current machine.

The diodes are in this case push-in rectifier diodes, which are directly connected via a press fit to the heat sink, which is in the form of a positive or negative pole.

Further advantages and details of the invention will be explained in the patent claims and in the description, and are illustrated in the figures, in which:

Figure 1 shows a perspective rear view of the rectifier with a heat sink and diode;

Figure 2 shows an illustration of part of the installed rectifier, in the area of a cooler fan;

Figure 3 shows a perspective illustration of the rectifier housing.

A rectifier housing 7 as shown in Figure 1 is used to hold a first heat sink 4.1 and a second heat sink 4.2. The heat sinks 4.1, 4.2 are in this case each fitted with two diodes 3.1, 3.2 which, overall, provide rectification of the applied AC voltage. In this case, two diodes 3.1, 3.2 are each electrically connected via a busbar 11, with the various busbars 11 likewise being electrically connected via three current links 10.1 to 10.3. The current links 10.1 to 10.3 are each attached to the rectifier housing 7 via a holding screw 12, which is used as an electrical power connection.

The heat sinks 4.1, 4.2 have two or more cooling ribs 5.1 which, as shown in Figure 1, are connected at their upper end, which holds the diodes 3.1, 3.2, and are in the form of laminates in the downward direction. The

laminates are open at their lower end. The heat sinks 4.1, 4.2 are mechanically connected to the rectifier housing 7 via two or more plastic screws 9.1 to 9.6. The rectifier housing 7 is open on a first face 7.1, which is aligned forwards in this case, with this open first face 7.1, as shown in Figure 2, facing a cooler fan housing 6.1 or a cooler fan 6 in the installed state.

A second face 7.2, which is illustrated at the rear in Figure 1, has two or more ventilation openings 7.3. The ventilation openings 7.3 are in this case arranged in the form of slots, parallel to one another. The ventilation openings 7.3 are aligned virtually vertically, as shown in Figure 1, matched to the cooling ribs 5.1. In addition, the rectifier housing 7 has further cooling openings on its lower face, opposite the plastic screws 9.1 to 9.6.

As can be seen from Figure 2, the rectifier housing 7 is screwed by its first face 7.1 to the cooler fan housing 6.1. The rectifier housing 7 is in this case arranged behind the cooler fan 6 with respect to the cooling air flow direction, so that the cooling air which is flowing through the cooler fan 6 passes through the rectifier housing 7, and thus through the heat sinks 4.1, 4.2, which are like laminates.

The current links 10.1 - 10.3 and the holding screws 7.3 are connected to the alternating current machine via the electrical connecting cable 8.1. The regulator 2.1 is directly electrically connected to the alternating current machine, which is arranged on the internal combustion engine, via a cable which is not illustrated. Furthermore, the heat sinks 4.1, 4.2, or the positive pole and the negative pole, are electrically connected to the DC voltage network of the internal combustion engine.

The cooler fan 6 is in this case attached directly to the frame longitudinal support 13 in the area of a coolant cooler, which is driven hydrostatically but is not illustrated. At least some of the cables 8.1 between a rectifier 2 or the positive and negative pole and the alternating current machine, which is not illustrated, are arranged in a cable duct 8. The cable duct 8 in this case forms an electromagnetic screen for the cables 8.1.

As can be seen from Figure 3, the rectifier housing 7 is kidney-shaped or in the form of part of a circle, corresponding to the circular shape of the cooler fan 6. In addition to the ventilation openings 7.3 on the second face 7.2, the rectifier housing 7 has additional ventilation openings on the outer side surface 7.4.

The rectifier housing 7 in this case forms a specific housing chamber for each heat sink 4.1, 4.2, so that the two heat sinks 4.1, 4.2 which form the positive pole and negative pole are electrically separated and isolated.

The alternating current machine is attached to the internal combustion engine via a cast combination support, which is not illustrated, together with a hydraulic pump for a hydrostatic fan. The pulley disc for the alternating current machine in this case has an effective diameter of 81 mm, thus resulting in a step-up ratio of i between the internal combustion engine and the alternating current machine of about i = 0.34.

List of reference symbols

2	Rectifier
2.1	Regulator
3.1	Diode
3.2	Diode
4.1	First heat sink, heat sink
4.2	Second heat sink, heat sink
5.1	Cooling rib
6	Cooler fan
6.1	Cooler fan housing
7	Rectifier housing
7.1	First face
7.2	Second face
7.3	Ventilation opening
7.4	Side surface
8	Cable duct
8.1	Cable
8.2	Cable
9.1	Plastic screw
9.2	Plastic screw
9.3	Plastic screw
9.4	Plastic screw
9.5	Plastic screw
9.6	Plastic screw
10.1	Current link
10.2	Current link
10.3	Current link
11	Busbar
12	Holding screws
12'	Holding screws
12''	Holding screws
13	Frame part, frame longitudinal support